

cryogenics

Study of the behavior of matter at temperatures below -200°C . The use of the liquefied gases oxygen, nitrogen, and hydrogen at approximately -260°C is standard industrial practice. Examples: Use of liquid nitrogen for quick-freezing of foods and of liquid oxygen in steel production. Some electronic devices and specialized instruments, such as the cryogenic gyro, operate at liquid-helium temperature (approximately 4 K). Many lasers and computer circuits require low temperature. Original research in this field was carried out by W. F. Giauque in the U.S. and by Kamerlingh-Onnes in Holland.

See superconductivity.

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catalyst

Any substance of which a small proportion notably affects the rate of a chemical reaction without itself being consumed or undergoing a chemical change. Most catalysts accelerate reactions, but a few retard them (negative catalysts, or inhibitors). Catalysts may be inorganic, organic, or a complex of organic groups and metal halides (see catalyst, stereospecific). They may be gases, liquids, or solids. In some cases their action is destructive and undesirable, as in the oxidation of iron to its oxide, which is catalyzed by water vapor, and similar types of corrosion. The life of an industrial catalyst varies from 1000 to 10,000 hours, after which it must be replaced or regenerated.

Though it is not a substance, light in both the visible and ultrashort wavelengths can act as a catalyst, as in photosynthesis and other photochemical reactions, e.g., as polymerization initiator and cross-linking agent.

Catalysts are highly specific in their application. They are essential in virtually all industrial chemical reactions, especially in petroleum refining and synthetic organic chemical manufacturing. For details of application, see the following list. Since the activity of a solid catalyst is often centered on a small fraction of its surface, the number of active points can be increased by adding promoters that increase the surface area in one way or another, e.g., by increasing porosity. Catalytic activity is decreased by substances that act as poisons that clog and weaken the catalyst surface, e.g., lead in the catalytic converters used to control exhaust emissions.

Besides inorganic substances, there are many organic catalysts that are vital in the life processes of plants and animals. These are called enzymes and are essential in metabolic mechanisms, e.g., pepsin in digestion. Synthetic organic catalysts have been developed that imitate the action of enzymes such as chymotrypsin. Such model catalysts are examples of biomimetic chemistry. They approach the catalytic activity of natural enzymes.

Following is a partial list of catalysts; an asterisk indicates a destructive effect.

Substance	Reaction Type
aluminum allyl + titanium chloride	Ziegler catalyst for stereospecific polymers
aluminum chloride	condensation (Friedel-Crafts)
aluminum oxide	hydration, dehydration
ammonia	condensation (polymers)
chromic oxide	methanol synthesis, aromatization, polymerization
cobalt	hydrocarbon synthesis (Oxo process)
copper salts	oxidation (of rubber)*
ferrie chloride	Friedel-Crafts
hydrogen fluoride	alkylation, condensation, dehydration, isomerization
iodine	condensation, alkylation
iron	ammonia synthesis, hydrocarbon synthesis
iron oxide	dehydrogenation (oxidation)
manganese dioxide	oxidation
molybdenum oxide	dehydrogenation, polymerization, aromatization, partial oxidation
nickel	hydrogenation (oils to fats), methanation
phosphoric acid	polymerization, isomerization
platinum metals	hydrogenation, aromatization, oxidation
silica-alumina	catalyzing hydrocarbons
silver	hydration, oxidation
sulfuric acid	isomerization, oxidation*
triethylaluminum	polymerization (stereospecific)
vanadium pentoxide	oxidation (sulfuric acid)
water (esp. + NaCl)	oxidation (corrosion)*
zeolites	catalyzing hydrocarbons

See catalysis; enzyme.

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